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NATIONAL DAM SAFETY PROGRAM. SILVER LAKE DAM (NJ00469), WALLKIL--ETC(U)
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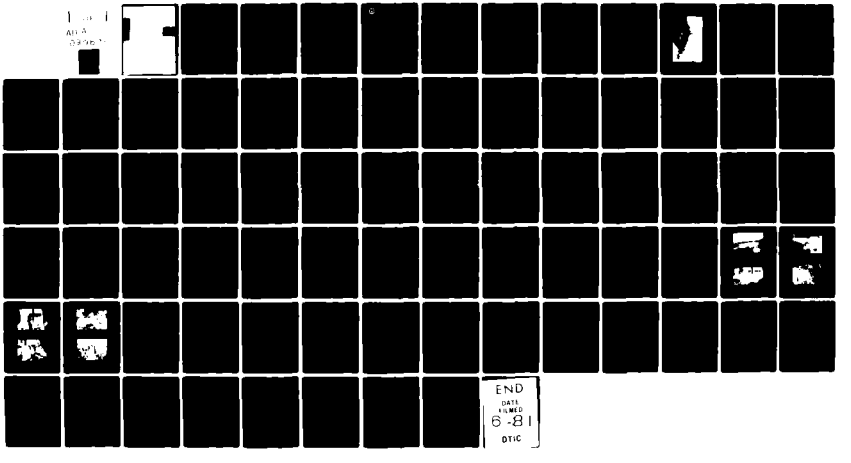

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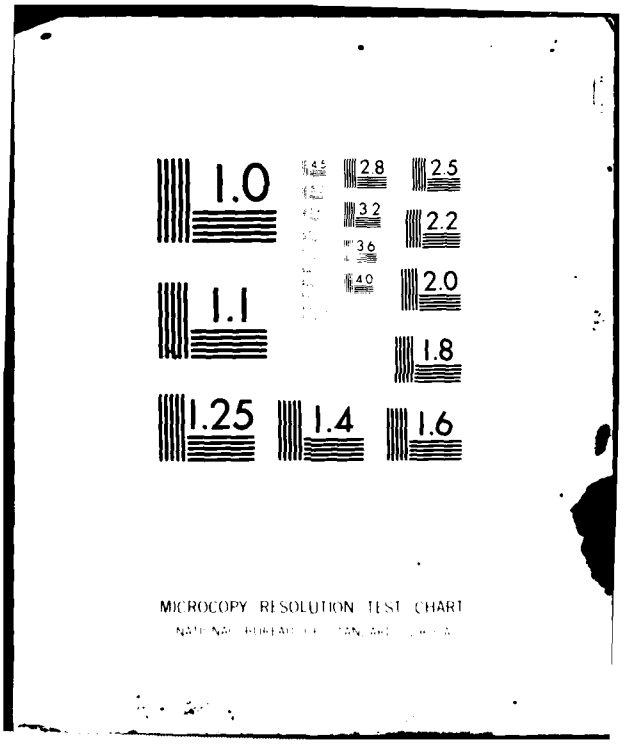
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REPORT DOCUMENTATION PAGE

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4. TITLE (and Subtitle): Phase I Inspection Report National Dam Safety Program Silver Lake Dam, NJ00469 Sussex County, N.J.	5. TYPE OF REPORT & PERIOD COVERED: FINAL
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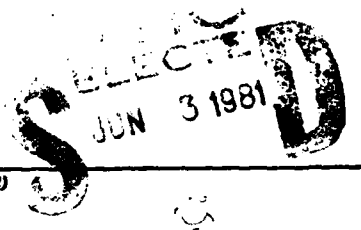

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18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia 22151.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dams	National Dam Safety Program
Embankments	Wallkill River Basin, NJ
Visual Inspection	Silver Lake Dam, NJ
Structural Analysis	Spillways
	Seepage

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

(1)

IN REPLY REFER TO
NAPEN-N

27 MAY 1981

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Silver Lake Dam in Sussex County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Silver Lake Dam, initially listed as a high hazard potential structure but reduced to a low hazard potential structure as a result of this inspection, is judged to be in good overall condition. However, the spillway is considered inadequate, as five percent of the 100 year design flood would cause the dam to be overtopped. The low hazard potential classification means that in the event of failure of the dam, no loss of life and only minimal economic loss is expected. For the same reasons no further studies or increase of spillway capacity are recommended. However, to assure the continued functioning of the dam and its impoundment, the following remedial actions could be undertaken by the owner:

a. Replace deteriorated stoplogs in the spillway.

b. Repair deteriorated concrete in the spillway structure.

c. Monitor the observed seepage at the left side of the dam at the toe of the slope on a periodic basis in order to detect any changes in volume or condition.

d. Develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Courter of the Thirteenth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

NAPEN-N
Honorable Brendan T. Byrne

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Inspection Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

Kenneth R. Moser

KENNETH R. MOSER
Major, Corps of Engineers
Acting District Engineer

1 Incl
As stated

Copies furnished:
Mr. Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

Mr. John O'Dowd, Acting Chief
Bureau of Flood Plain Regulation
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

SILVER LAKE DAM (NJ00469)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 19 December 1980 by Storch Engineers, under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Silver Lake Dam, initially listed as a high hazard potential structure but reduced to a low hazard potential structure as a result of this inspection, is judged to be in good overall condition. However, the spillway is considered inadequate, as five percent of the 100 year design flood would cause the dam to be overtopped. The low hazard potential classification means that in the event of failure of the dam, no loss of life and only minimal economic loss is expected. For the same reasons no further studies or increase of spillway capacity are recommended. However, to assure the continued functioning of the dam and its impoundment, the following remedial actions could be undertaken by the owner:

a. Replace deteriorated stoplogs in the spillway.

b. Repair deteriorated concrete in the spillway structure.

c. Monitor the observed seepage at the left side of the dam at the toe of the slope on a periodic basis in order to detect any changes in volume or condition.

d. Develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

APPROVED: Kenneth R. Moser

KENNETH R. MOSER
Major, Corps of Engineers
Acting District Engineer

DATE: 26 May 1981

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Silver Lake Dam, I.D. NJ00469
State Located:	New Jersey
County Located:	Sussex
Drainage Basin:	Wallkill River
Stream:	Tributary to Franklin Pond Creek
Date of Inspection:	December 19, 1980

Assessment of General Condition of Dam

Based on visual inspection, past operational performance and Phase I engineering analyses, Silver Lake Dam is assessed as being in good overall condition.

Based on investigations of the downstream flood plain made in connection with this report, it is recommended that the hazard potential classification be downgraded from high to low hazard.

Hydraulic and hydrologic analyses indicate that the spillway is inadequate. Discharge from the spillway is not sufficient to pass the designated spillway design flood (100-year storm) without an overtopping of the dam. The spillway is capable of passing approximately 4 percent of the SDF. However, because of the low hazard classification, no further studies or increase of spillway capacity are recommended.

The observed seepage at the left side of the dam at the toe of slope should be monitored on a periodic basis by a professional engineer experienced in the design and construction dams in order to detect any changes in volume or condition.

In addition, it is recommended that the following remedial measures be undertaken in the future:

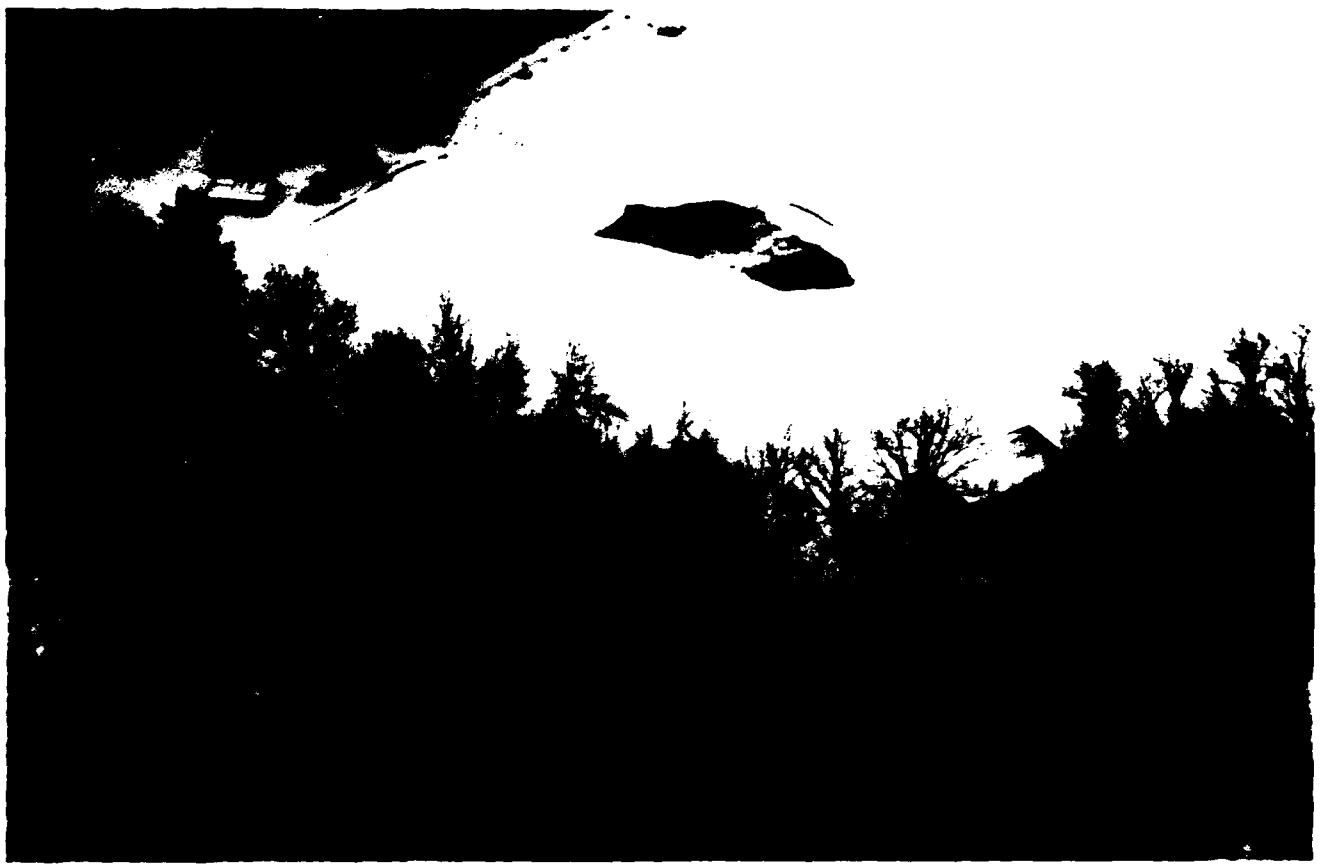
1) Deteriorated stoplogs in the spillway should be replaced.

2) Deteriorated concrete in the spillway structure should be repaired.

In the future, the owner of the dam should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

Richard J. McDermott, P.E.

John E. Gribbin, P.E.



OVERVIEW - SILVER LAKE DAM

20 JANUARY 1981

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that the unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydraulic and hydrologic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydraulic and hydrologic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

SILVER LAKE DAM, I.D. NJ00469

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The Division of Water Resources of the New Jersey Department of Environmental Protection (NJDEP) in cooperation with the Philadelphia District of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the State of New Jersey. Storch Engineers has been retained by the NJDEP to inspect and report on a selected group of these dams. The NJDEP is under agreement with the Philadelphia District of the Corps of Engineers.

b. Purpose of Inspection

The visual inspection of Silver Lake Dam was made on December 19, 1980. The purpose of the inspection was to make a general assessment of the structural integrity and operational adequacy of the dam structure and its appurtenances.

1.2 Description of Project

a. Description

The dam is an earth dam with a stone masonry wall comprising the upstream face and a stone rubble wall forming the downstream face. In the center of the dam is a concrete spillway structure. The spillway is formed by three sets of timber stoplogs fitted at the upstream end of two concrete piers and two concrete abutments. The center stoplogs serve as a primary crest while the outer sets comprise secondary crests. The primary and secondary spillway crest elevations are 1069.7 and 1070.2, respectively, while that of the crest of dam is 1071.0, National Geodetic Vertical Datum (N.G.V.D.). A timber walkway spans the discharge channels which are formed by the concrete abutments and piers described above. The overall length of dam is 171 feet and its height is 10.7 feet.

b. Location

Silver Lake Dam is located in the Township of Hardyston, Sussex County, New Jersey. Principal access to the dam is by Silver Lake YMCA Camp of which Silver Lake is a part. The camp is located approximately 1 mile north of N.J. Route 23. Discharge from the spillway of the dam flows into a tributary of the Franklin Pond Creek.

c. Size and Hazard Classification

The dam is classified in accordance with criteria presented in "Recommended Guidelines for Safety Inspection of Dams" published by the U.S. Army Corps of Engineers. Size categories consist of Small, Intermediate and Large while hazard categories are designated as Low, Significant and High.

Size Classification: Silver Lake Dam is classified as "Small" size since its maximum storage volume is 88 acre-feet (which is less than 1000 acre-feet) and its height is 10.7 feet (which is less than 40 feet).

Hazard Classification: Visual inspection of the downstream flood plain of the dam indicates that failure of the dam would not cause significant property damage downstream from the dam. It is anticipated that dam failure during a storm equivalent to the SDF could cause minor damage to a road bridge located 1800 feet downstream from the dam. Loss of life resulting from dam failure would not be anticipated. Reportedly, no Silver Lake YMCA Camp activities are designated for the area downstream from the dam. Accordingly, Silver Lake Dam is classified as "Low" hazard.

d. Ownership

Silver Lake Dam is owned by the Y.M.C.A. of Northern Passaic Valley, 128 Ward St., Paterson, N.J. 07505.

e. Purpose of Dam

The purpose of the dam is the impoundment of a recreational lake facility.

f. Design and Construction History

Reportedly, Silver Lake Dam was constructed in 1948. Reportedly, no records or plans for the dam are on file.

g. Normal Operational Procedures

The dam and appurtenances are operated and maintained by the Silver Lake YMCA Camp maintenance crew. There is a weekly

check of water level and outlet works made by the maintenance personnel.

The lake was last lowered in 1976 in order to reconstruct the spillway.

1.3 Pertinent Data

a.	Drainage Area	0.70 square miles
b.	Discharge at Damsite	
	Maximum flood at damsite	Unknown
	Outlet Works at pool elevation	62 cfs.
	Spillway capacity at top of dam	30 cfs
c.	Elevation (N.G.V.D.)	
	Top of Dam	1071.0
	Maximum pool-design surcharge	1072.3
	Recreation pool	1070.0
	Spillway crest	1070.0
	Stream bed at centerline of dam	1060.1
	Maximum tailwater	1065 (Estimated)
d.	Reservoir	
	Length of maximum pool	2000 feet (Estimated)
	Length of recreation pool	1800 feet (Scaled)
e.	Storage (Acre-feet)	
	Recreation pool	67
	Design surcharge	117
	Top of dam	88

f. Reservoir Surface (acres)

Top of dam	21.0 (Estimated)
Maximum pool - design surcharge	24.5 (Estimated)
Recreation pool	20.2

g. Dam

Type	Earthfill
Length	171 feet
Height	10.9 feet
Sideslopes - Upstream	Vertical
- Downstream	1 horiz. to 2 vert.
Zoning	Unknown
Impervious core	Unknown
Cutoff	Unknown
Grout curtain	Unknown

h. Diversion and Regulating Tunnel — N.A.

i. Spillway

Type	Sharp Crested Weir (Stoplogs)
Length of weir - Primary	5.0 feet
- Secondary	9.6 feet
Crest elevation - Primary	1069.7
- Secondary	1070.2
Approach channel	N.A.
Discharge channel	Concrete rectangular channels through dam

j. Regulating Outlet

3 sets of stoplogs

SECTION 2: ENGINEERING DATA

2.1 Design

No plans or calculations pertaining to the original construction of the dam could be obtained.

2.2 Construction

No data or reports pertaining to the construction of the dam are available.

2.3 Operation

No data or reports pertaining to the operation of the dam are available.

2.4 Evaluation

a. Availability

No data or reports pertaining to the operations of the dam are available.

b. Adequacy

Available engineering data pertaining to Silver Lake Dam is not adequate to be of significant assistance to the performance of a Phase I evaluation. A list of absent information is included in paragraph 7.1.b.

c. Validity

The validity of engineering data cannot be assessed due to the absence of data.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

The inspection of Silver Lake Dam was performed on December 19, 1980 by staff members of Storch Engineers. A copy of the visual inspection check list is contained in Appendix 1. The following procedures were employed for the inspection:

1) The embankment of the dam, appurtenant structures and adjacent areas were examined.
2) The embankment and accessible appurtenant structures were measured and key elevations determined by surveyor's level.
3) The embankment, appurtenant structures and adjacent areas were photographed.
4) The downstream flood plain was toured to evaluate downstream development and restricting structures.

b. Dam

The walls forming the upstream and downstream face of embankment appeared to be in satisfactory condition. The crest of dam was uniformly graded and grass covered. An earth slope was observed on the downstream side of the dam extending downward from the toe of the stone rubble wall. The slope, which was covered with trees ranging in size from one inch to six inches, is reportedly part of the original terrain existing before the dam was constructed. At the toe of this slope left of the spillway, two areas of standing water were observed. The standing water could possibly be due to seepage.

c. Appurtenant Structures

The concrete surfaces in the discharge channels appeared to be generally sound, although there was some deterioration noted at the downstream end. The left abutment was spalled and cracked near its downstream end. The slabs forming the bottoms of the channels were eroded and spalled at their downstream ends where the water spills over. Also the interface between the training walls and the bottom slabs appeared to be eroded.

Some of the timber stoplogs were buckled and leaking. The remaining stoplogs appeared to be in satisfactory condition. The timber walkway spanning the discharge channel was in satisfactory condition.

d. Reservoir Area

The right side of the reservoir consisted of a camp with camp buildings. The buildings appeared to be approximately 5 feet above the reservoir level. The upstream end and left side of the reservoir are thickly wooded. The shore slopes are approximately 50 percent. The shore slopes on the right side are also 50 percent but then level off after a height of about 5 feet.

e. Downstream Channel

The downstream channel is a natural stream with a sandy, gravelly bottom and some rocks along the banks. The stream is wooded to its banks. It has banks about 1 foot high with the terrain beyond sloping away at approximately a 5 percent grade. Approximately 8 to 10 feet downstream from the spillway there is a drop in the channel bed formed by rocks. The channel bed between the spillway and the drop is gravelly and did not appear to be scoured.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

The level of water in Silver Lake is regulated by discharge over the spillway weirs. Reportedly, during severe storms, the spillway capacity is augmented by pulling stoplogs.

The most recent drawdown of the lake occurred in 1976 when camp personnel drew the lake down a total of three feet in order to reconstruct the spillway.

4.2 Maintenance of the Dam

Reportedly, maintenance is performed on an "as needed" basis. The camp maintenance department inspects the water level on a weekly basis and performs repairs, if necessary. The most recent maintenance consisted of the reconstruction of the spillway in 1976.

4.3 Maintenance of Operating Facilities

Reportedly, maintenance of operating facilities is performed on an "as needed" basis.

4.4 Description of Warning System

Reportedly, no warning system is currently in use for the dam although the dam is checked during storms by camp maintenance personnel.

4.5 Evaluation of Operational Adequacy

The operation of the dam has been successful to the extent that the dam reportedly has not been overtopped.

Although maintenance has been good in some areas, a few aspects of dam maintenance have not been adequately performed, inlcuding the following:

1) Spalled and cracked concrete in spillway structure not repaired.
2) Deformed stoplogs not replaced.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

The quantity of storm water runoff that the spillway should be able to handle is based on the size and hazard classification of the dam. This runoff quantity, called the spillway design flood (SDF) is described in terms of return frequency or probable maximum flood (PMF) depending on the extent of the dam's size and potential hazard. According to the "Recommended Guidelines for Safety Inspection of Dams" published by the U.S. Army Corps of Engineers, the SDF for Silver Lake Dam falls in a range of 50-year frequency to 100-year frequency. In this case, the high end of the range, 100-year frequency, is chosen since the factors used to select hazard classification are on the high end of their range.

The SDF peak computed for Silver Lake Dam is 761 c.f.s. This value is derived from the 100-year flood hydrograph computed by the use of the HEC-1-DAM Flood Hydrograph Computer Program using the Soil Conservation Service triangular unit hydrograph with curvilinear transformation. Hydrologic computations and computer output are contained in Appendix 4.

The spillway discharge rates were computed by the use of weir and orifice formulae appropriate for the configuration of the spillway structure with stoplogs left in place. The total spillway discharge with lake level equal to the top of the dam was computed to be 30 c.f.s. The SDF was routed through the dam by use of the HEC-1-DAM computer program using the modified Puls Method. In routing the SDF, it was found that the dam crest would be overtopped by a depth of 1.3 feet. Accordingly, the subject spillway is assessed as being inadequate in accordance with criteria developed by the U.S. Army Corps of Engineers.

b. Experience Data

Reportedly, the dam has not been overtopped since its construction.

c. Visual Observation

No evidence was found at the time of inspection that would indicate that the dam had been overtopped.

d. Overtopping Potential

As indicated in paragraph 5.1.a. a storm of magnitude equal to the SDF would cause overtopping of the dam by a depth of 1.3 feet over the crest of the dam. The spillway is capable of passing approximately 4 percent of the SDF with the lake level equal to the top of dam.

e. Drawdown Data

Drawdown of the lake is accomplished by removing the timber stoplogs. The lake can be drawn down a total of 2.3 feet in this manner. Total time for drawdown is estimated to be approximately 27 hours (see Appendix 4).

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

The dam appeared, at the time of inspection to be outwardly structurally sound with no evidence of embankment cracks or distress. Evidence of possible seepage was observed at the left side of the dam at the toe of slope. The vertical cracks observed in the downstream abutment wall on the left side of the spillway did not appear to be an indication of distress in the spillway structure or the embankment.

b. Generalized Soils Description

The generalized soils description of the dam site consists of the gray granitoid gneiss identified as the "Pre-Cambrian Byram Gneiss" on the Geologic Map of New Jersey. The bedrock, presumably extends below the dam foundation. Shallow soils of silt, sand and boulders, derived from the gneiss cover shallow pockets in the bedrock.

A muck area flanks the northwest. This area consists of poorly drained material composed primarily of peat deposits which accumulated during the Wisconsin stage of continental glaciation.

c. Design and Construction Data

Analysis of structural stability and construction data for the embankment are not available.

d. Operating Records

No operating records are available for the dam. The water level of Silver Lake is monitored by observation on a weekly basis by the maintenance crews.

e. Post-Construction Changes

Reportedly, in 1976 the lake was drawn down 3 feet for the reconstruction of the spillway.

f. Seismic Stability

Silver Lake Dam is located in Seismic Zone 1 as defined in "Recommended Guidelines for Safety Inspection of Dams" which is a zone of very low seismic activity. Experience indicates that dams in Seismic Zone 1 will have adequate stability under seismic loading conditions if they have adequate stability under static loading conditions. Silver Lake Dam appeared to be stable under static loading conditions at the time of inspection.

SECTION 7: ASSESSMENT AND RECOMMENDATIONS

7.1 Dam Assessment

a. Safety

Based on hydraulic and hydrologic analyses outlined in Section 5 and Appendix 4, the spillway of Silver Lake Dam is assessed as being inadequate. The spilllway is not able to pass the SDF without an overtopping of the dam.

The embankment appeared, at the time of inspection, to be generally outwardly stable. Observed cracks in the spillway structure and possible seepage are not considered to be evidence of immediate dam instability

b. Adequacy of Information

Information sources for this report include 1) field inspections, 2) USGS quadrangle, and 3) consultation with YMCA personnel. The information obtained is sufficient to allow a Phase I assessment as outlined in "Recommended Guidelines for Safety Inspection of Dams."

Some of the absent data are as follows:

1. Construction and as-built drawings.
2. Description of fill material for embankment.
3. Design computations and reports.
4. Soils report for the site.
5. Inspection reports.

c. Necessity for Additional Data/Evaluation

Although some data pertaining to Silver Lake Dam are not available, additional data are not considered imperative for this Phase I evaluation.

7.2 Recommendations

a. Remedial Measures

Based on hydraulic and hydrologic analyses outlined in paragraph 5.1.a, the spillway is considered to be inadequate. However, because of the low hazard classification, no further studies or increase of spillway capacity are recommended.

However, it is recommended that the following remedial measures be undertaken by the owner in the near future.

1) Deteriorated stoplogs in the spillway should be replaced.
2) Deteriorated concrete in the spillway structure should be repaired.

b. Maintenance

In the future, the owner of the dam should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

c. Additional Studies

The observed seepage at the left side of the dam at the toe of slope should be monitored on a periodic basis by a professional engineer experienced in the design and construction of dams in order to detect any changes in volume or condition.

PLATES

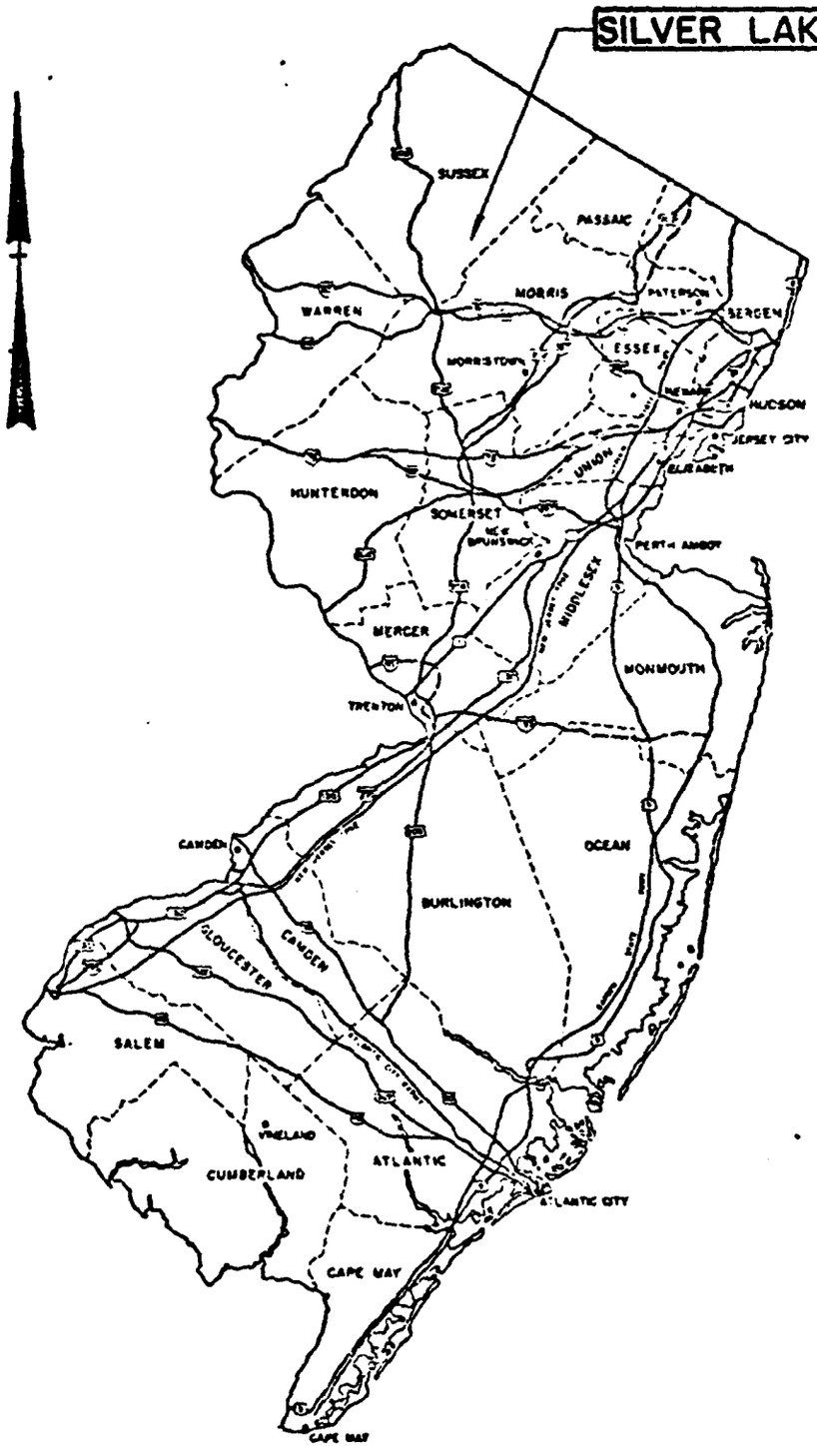
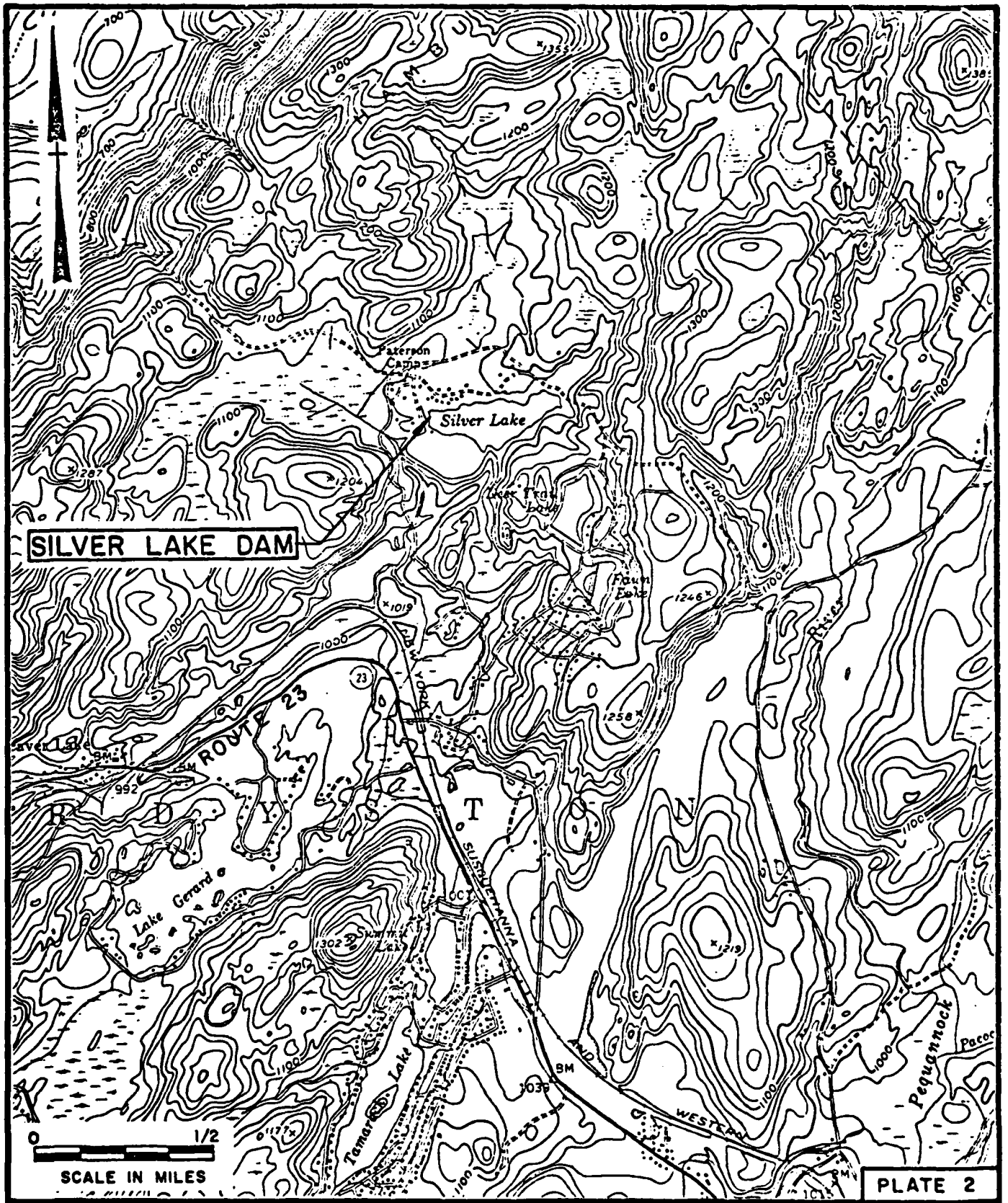


PLATE 1

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	INSPECTION AND EVALUATION OF DAMS KEY MAP SILVER LAKE DAM
DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY	SCALE: NONE DATE: FEB. 1981



STORCH ENGINEERS
FLORHAM PARK, NEW JERSEY

DIVISION OF WATER RESOURCES
N.J. DEPT. OF ENVIR. PROTECTION
TRENTON, NEW JERSEY

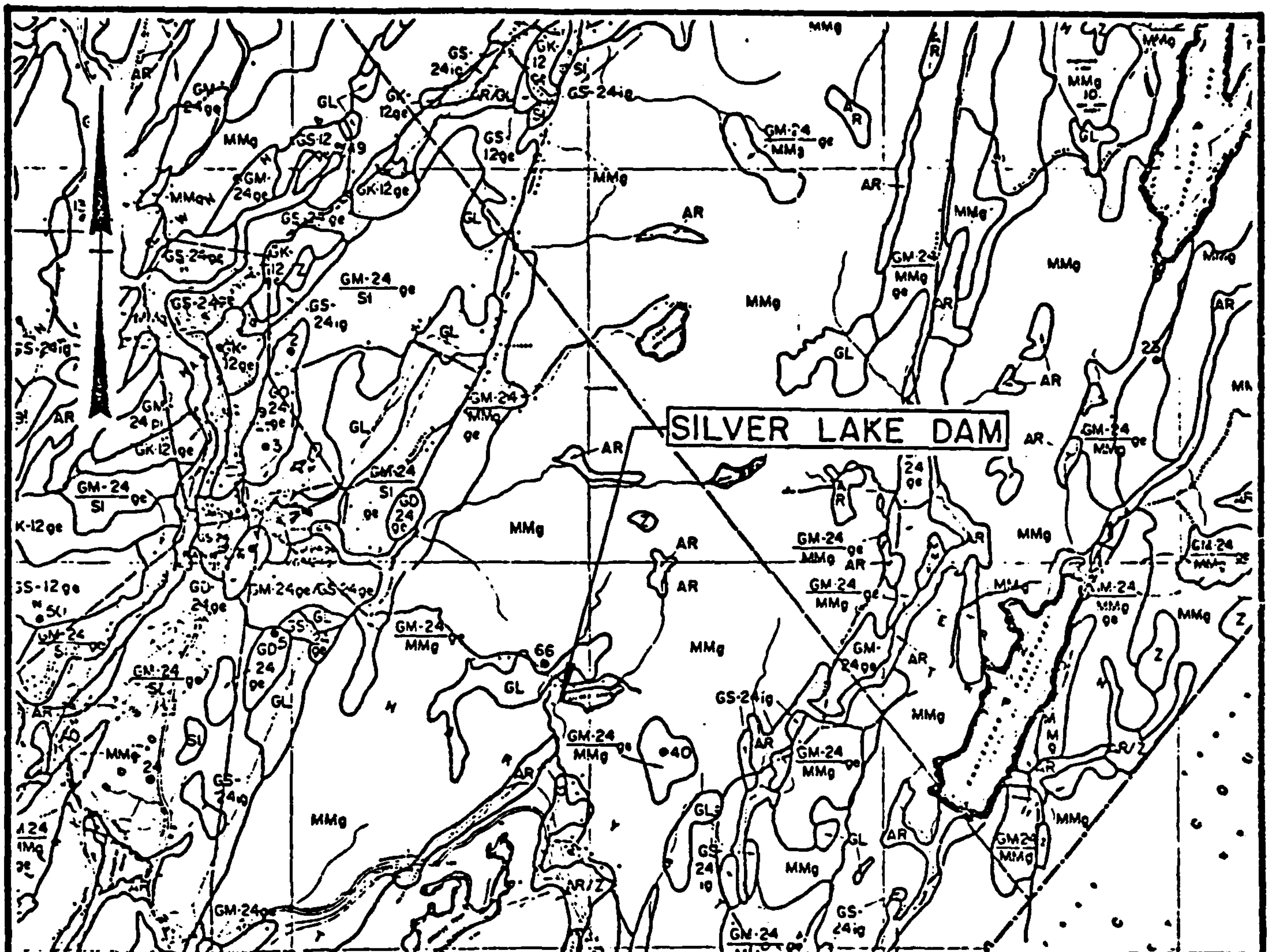
INSPECTION AND EVALUATION OF DAMS

VICINITY MAP

SILVER LAKE DAM

SCALE: AS SHOWN

DATE: FEB. 1981



Legend

MMg — Gneissic bedrock, shown as Losee gneiss on the Geologic Map of New Jersey

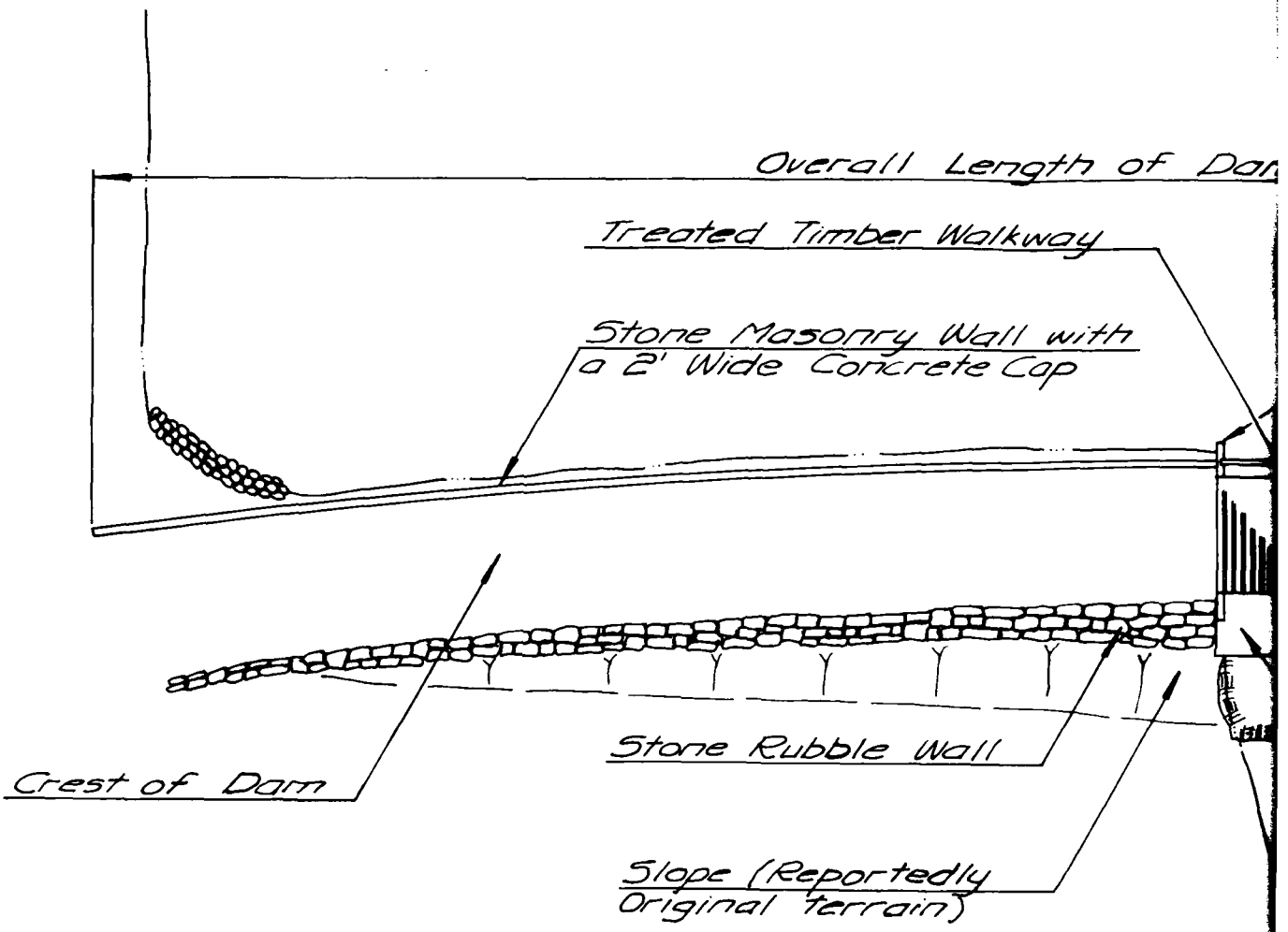
GL — Poorly drained material composed primarily of peat deposits which accumulated in shallow glacial lakes and swamps, formed during the Wisconsin stage of continental glaciation.

Note: Information taken from Rutgers University, Soil Survey of New Jersey, Report No. 11, Sussex County, November 1953 and Geologic Map of New Jersey prepared by J. V. Lewis and H. Kummel 1910-1912, revised by H. B. Kummel 1931 and M. Johnson 1950.

PLATE 3

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY.	INSPECTION AND EVALUATION OF DAMS SOIL MAP SILVER LAKE DAM
DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY.	SCALE: NONE DATE: FEB, 1981

SILVER L



Note Information taken from field Inspection December 19, 1980.

/ER LAKE

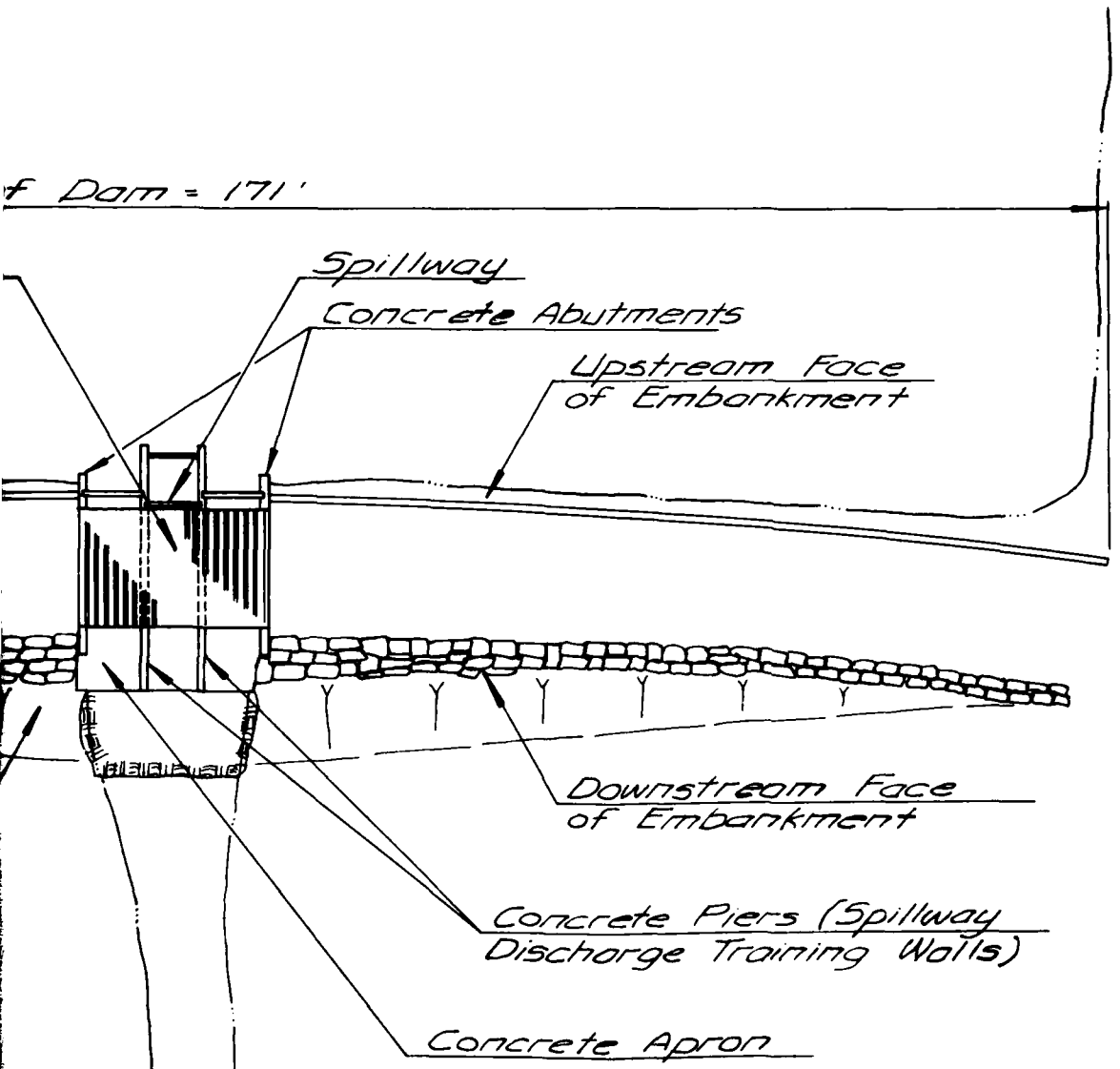


PLATE 4

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

GENERAL PLAN

SILVER LAKE DAM

I.D. N.J. 00469	SCALE: NOT TO SCALE
	DATE: MARCH, 1981

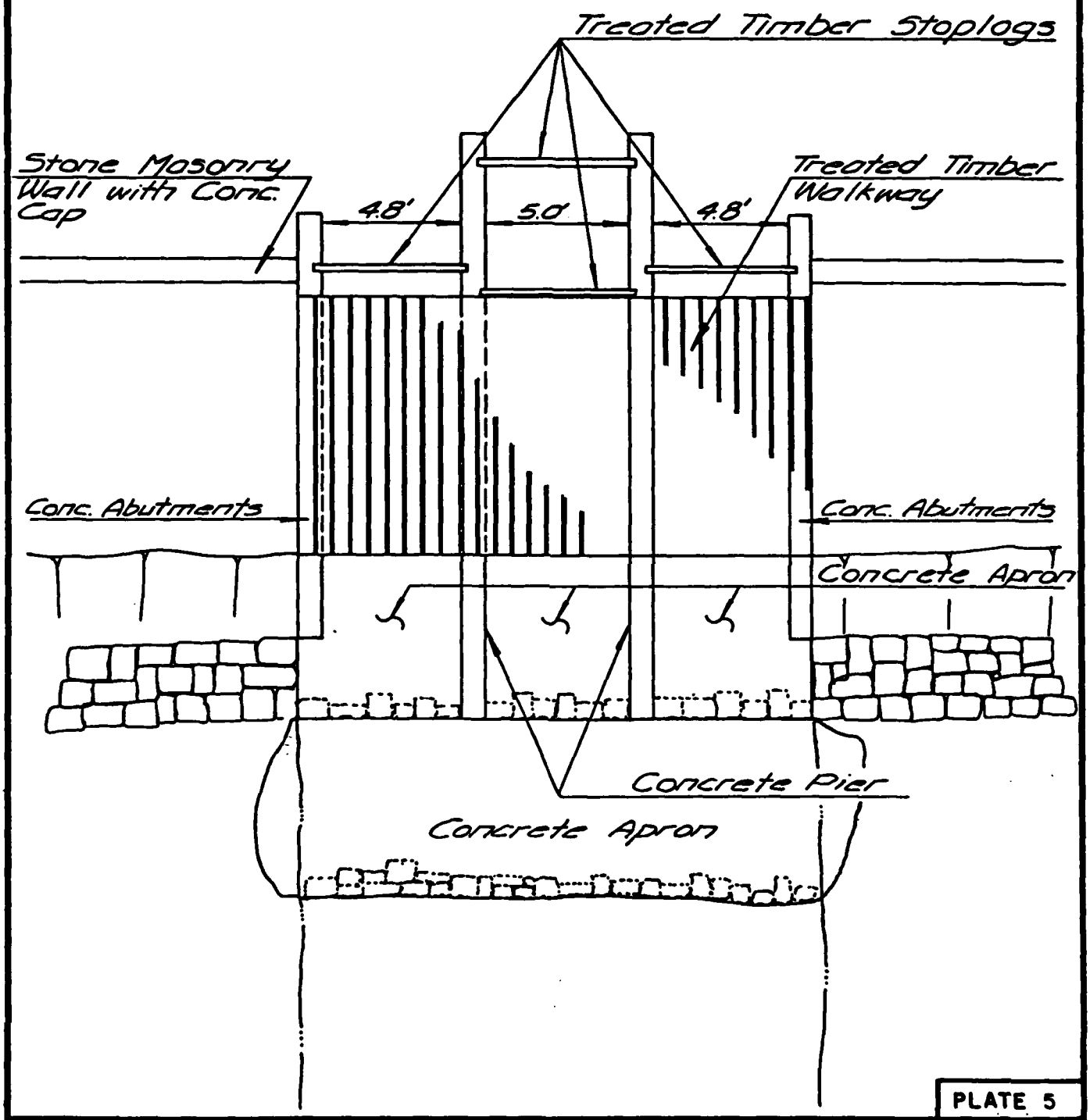


PLATE 5

STORCH ENGINEERS
FLORHAM PARK, NEW JERSEY

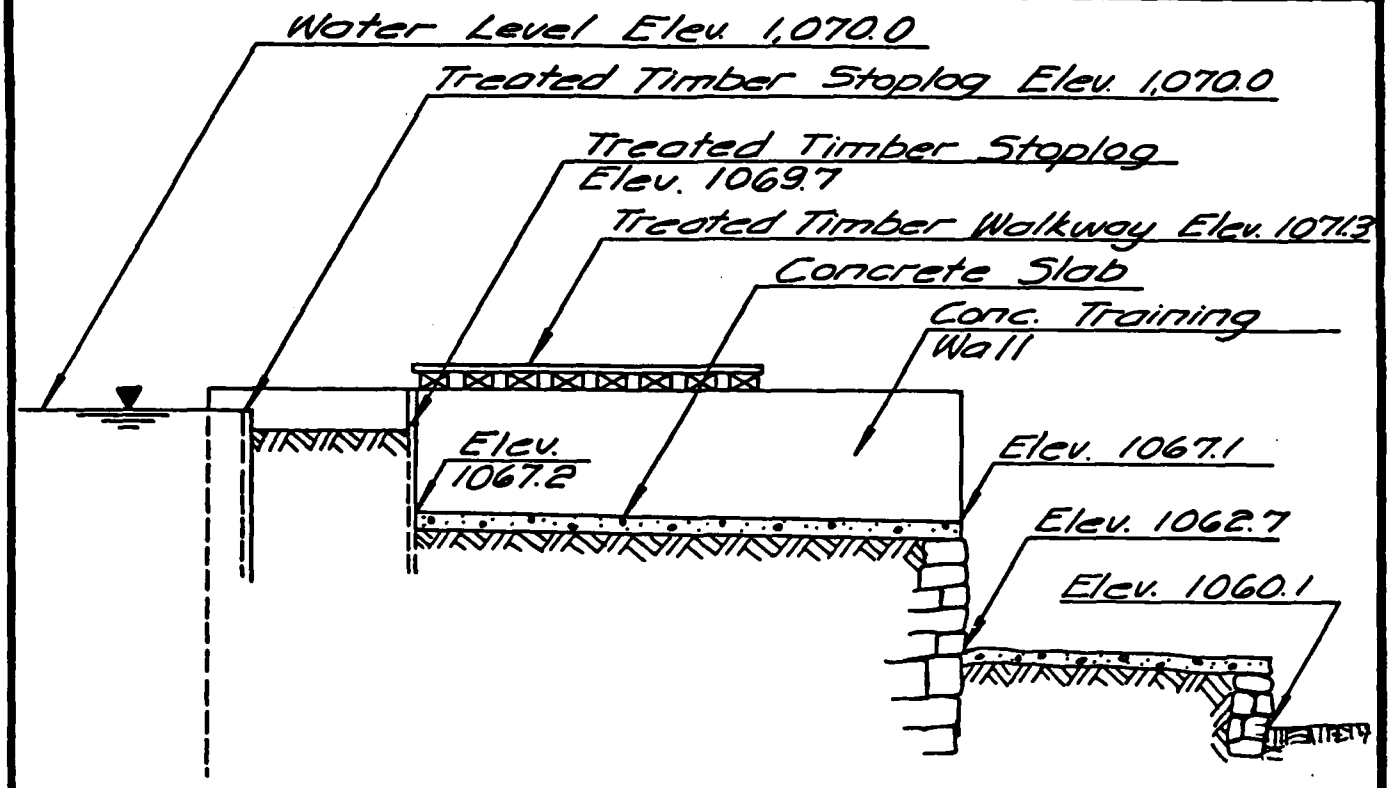
DIVISION OF WATER RESOURCES
N.J. DEPT. OF ENVIR. PROTECTION
TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

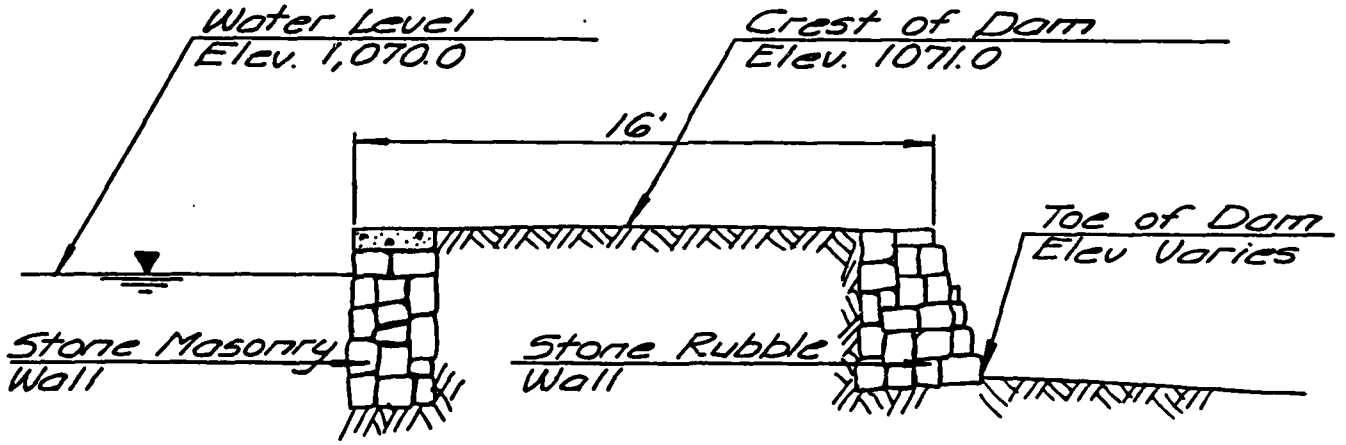
SPILLWAY PLAN

SILVER LAKE DAM

I.D. N.J. 00469	SCALE: NONE
	DATE: MARCH, 1981



SPILLWAY SECTION

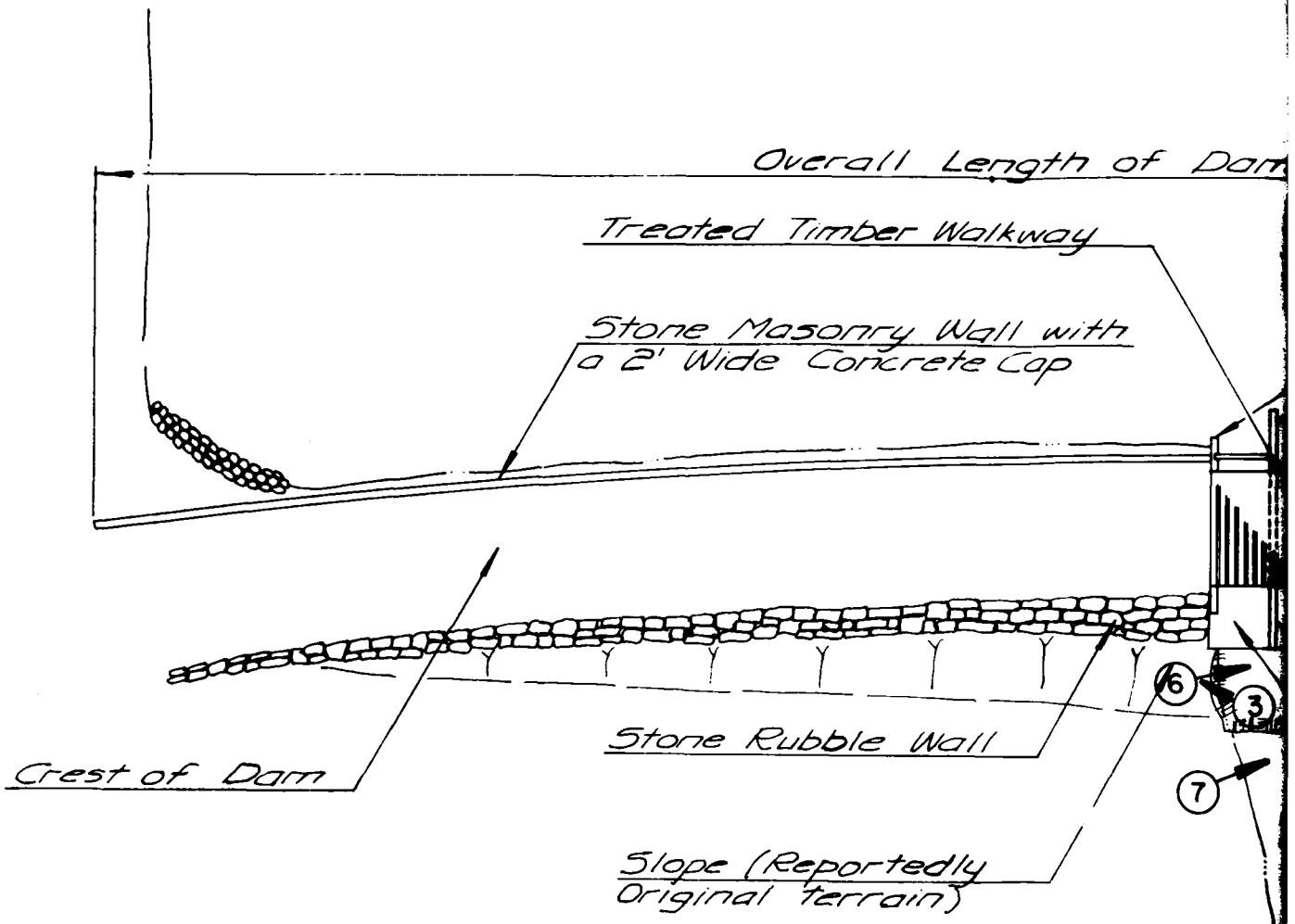


TYPICAL DAM SECTION

PLATE 6

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	INSPECTION AND EVALUATION OF DAMS SECTIONS SILVER LAKE DAM
DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY	I.D. N.J. 00469 | SCALE: NONE DATE: MARCH, 1981

SILVER LA



Note: Information taken from field Inspection December 19, 1980.

ER LAKE

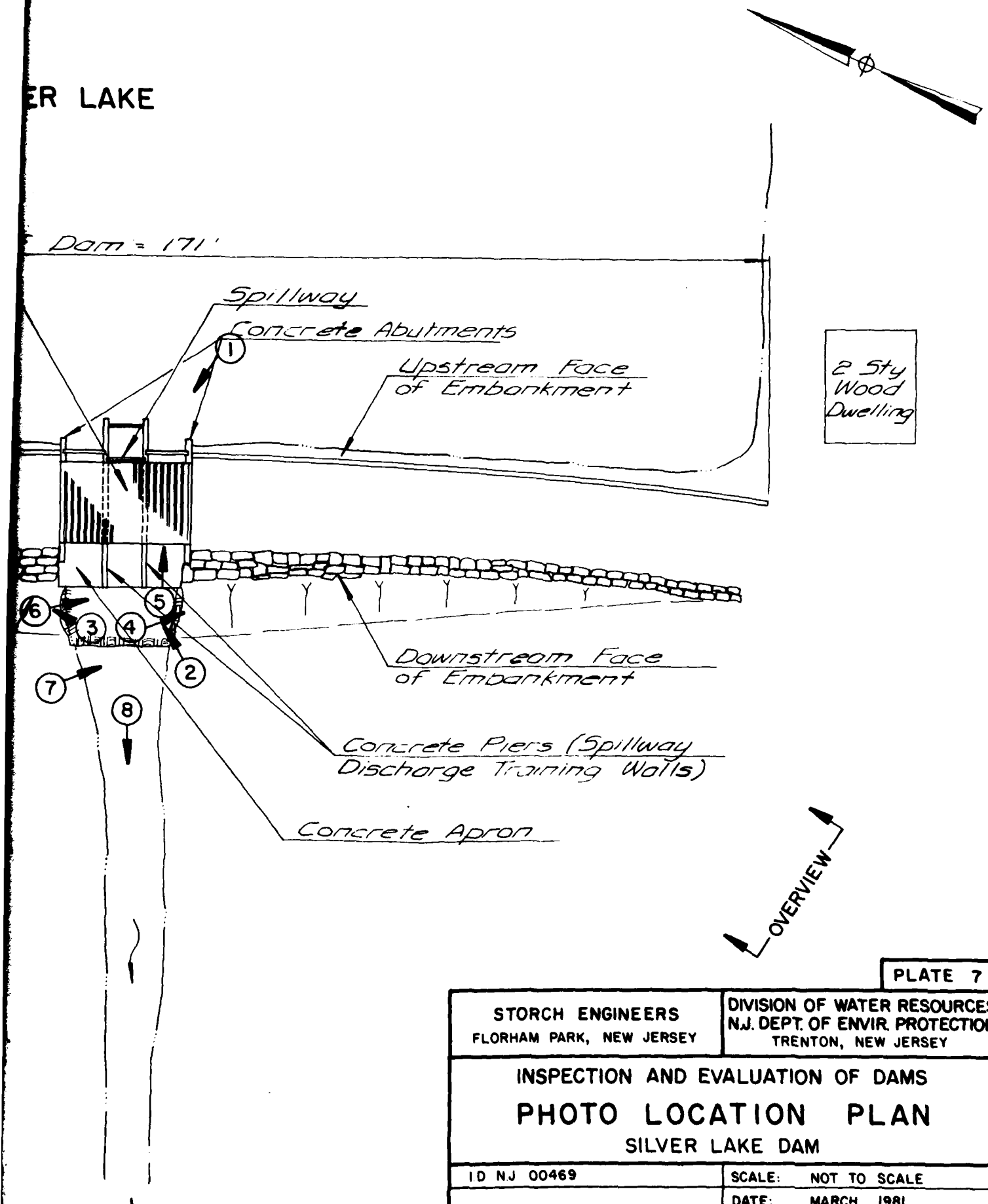


PLATE 7

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

PHOTO LOCATION PLAN

SILVER LAKE DAM

I.D. NJ 00469	SCALE: NOT TO SCALE
	DATE: MARCH, 1981

APPENDIX 1

Check List - Visual Inspection

Check List - Engineering Data

Check List

Visual Inspection

Phase I

Name of Dam Silver Lake Dam County Sussex State N.J. Coordinators NJDEP

Date(s) Inspection 12/19/80 Weather P. Cloudy Temperature 30°F

Pool Elevation at time of Inspection 1070.0 M.S.L. Tailwater at Time of Inspection 1060.0 M.S.L.

Inspection Personnel:

John Gribbin	William Carson	
Charles Osterkorn	Richard McDermott	
Daniel Buckelew		

John Gribbin Recorder

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
GENERAL	Crest covered with grass. Slope downstream from toe of downstream wall covered with trees (1" to 6").	Downstream slope reportedly part of original terrain before dam was constructed.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Appeared sound.	
ANY NOTICEABLE SEEPAGE	Two areas of standing water observed at toe of slope, left of spillway. Standing water could possibly be seepage.	Possible seepage should be monitored.
STAFF GAGE AND RECORDER	None observed.	
DRAINS	None observed.	

EMBANKMENT

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None observed	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Vertical: level Horizontal: straight	
RIPRAP	No riprap observed. However, upstream and downstream sides stabilized by stone masonry and stone rubble walls, respectively. Walls in satisfactory condition.	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SURFACES IN OUTLET CONDUIT	See Spillway	Spillway serves as outlet works
INTAKE STRUCTURE	N.A.	
OUTLET STRUCTURE	See Spillway	
OUTLET CHANNEL	See Spillway	
GATE AND GATE HOUSING	Stoplogs serve as gates. See Spillway	Invert of stoplogs above invert of downstream channel. Outlet may not be suitable as low level outlet.

SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
WEIR	Three sets of timber stoplogs. Some of the stoplogs were buckled and deformed allowing leakage.	Deformed stoplogs should be replaced.
APPROACH CHANNEL	N.A.	
DISCHARGE CHANNEL	Concrete piers, abutments and bottom slabs appeared sound. However, concrete surfaces near downstream end were eroded, spalled and cracked.	Concrete should be repaired.
WALKWAY	Timber walkway spanning discharge channel appeared to be in satisfactory condition.	

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None observed	
OBSERVATION WELLS	None observed	
WEIRS	None observed	
PIEZOMETERS	None observed	
OTHER	N.A.	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Shore slopes approx. 50%. Thickly wooded along upstream and left shores.	
SEDIMENTATION	Unknown.	
STRUCTURES ALONG BANKS	Camp related buildings along right shore. Buildings approx. 5' above water level.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTION, DEBRIS, ETC.)	Natural stream with sandy, gravelly bottom with rocks along banks, wooded to water line.	
SLOPES	Banks about 1' high. Terrain beyond banks slopes up at about 5%.	
STRUCTURES ALONG BANKS	Road bridge about 1800 feet from dam.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM			REMARKS
DAM	-	PLAN	Not available
		SECTIONS	
SPILLWAY	-	PLAN	Not available
		SECTIONS	
		DETAILS	
OPERATING EQUIPMENT PLANS & DETAILS			Not available
OUTLETS	-	PLAN	Not available
		DETAILS	
		CONSTRAINTS	
		DISCHARGE RATINGS	
HYDRAULIC/HYDROLOGIC DATA			Not available
RAINFALL/RESERVOIR RECORDS			Not available
CONSTRUCTION HISTORY			Not available
LOCATION MAP			Not available

ITEM	REMARKS
DESIGN REPORTS	Not available
GEOLOGY REPORTS	Not available
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM INSTABILITY SEEPAGE STUDIES	Not available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Not available
POST-CONSTRUCTION SURVEYS OF DAM	Not available
BORROW SOURCES	Not available

ITEM	REMARKS
MONITORING SYSTEMS	None
MODIFICATIONS	Reportedly, spillway reconstructed in 1976; data not available
HIGH POOL RECORDS	Not available
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Not available
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None
MAINTENANCE OPERATION RECORDS	Not available

APPENDIX 2

Photographs

PHOTO 1

UPSTREAM VIEW OF SPILLWAY

PHOTO 2

DOWNSTREAM VIEW OF SPILLWAY

SILVER LAKE DAM
19 DECEMBER 1980

PHOTO 3

DOWNSTREAM SIDE OF SPILLWAY AND
EMBANKMENT - RIGHT SECTION

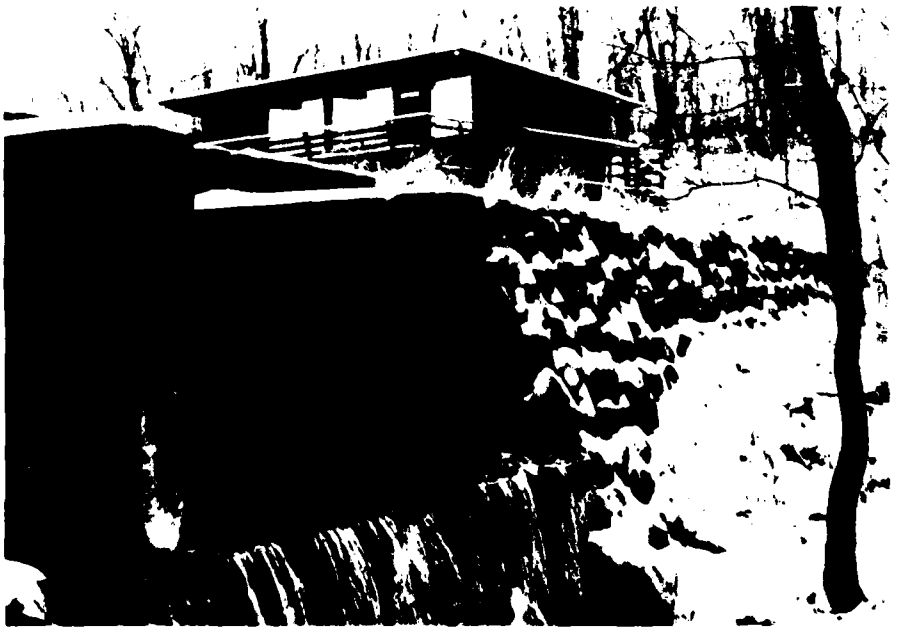


PHOTO 4

DOWNSTREAM SIDE OF SPILLWAY AND
EMBANKMENT - LEFT SECTION

SILVER LAKE DAM
19 DECEMBER 1980

PHOTO 5

LEFT SPILLWAY DISCHARGE CHANNEL WITH
STOPLOGS AT UPSTREAM END

PHOTO 6

SPILLOVER AT DOWNSTREAM END OF SPILLWAY

SILVER LAKE DAM
19 DECEMBER 1980

PHOTO 7

STEP IN DOWNSTREAM CHANNEL BED
ABOUT 10 FEET FROM SPILLWAY

PHOTO 8

DOWNSTREAM CHANNEL

SILVER LAKE DAM
19 DECEMBER 1980

APPENDIX 3

Engineering Data

CHECK LIST

HYDROLOGIC AND HYDRAULIC DATA

ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Wooded, hilly

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1070.0 (67 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): N.A.

ELEVATION MAXIMUM DESIGN POOL: 1072.3

ELEVATION TOP DAM: 1071.0

SPILLWAY CREST: 2-Stage Weir

a. Elevation 1069.7 (Primary), 1070.2 (Secondary)

b. Type Sharp - Crested Weir

c. Width 0.2 Feet

d. Length 5 Feet (Primary) 9.6 Feet (Secondary)

e. Location Spillover Upstream Side of Dam

f. Number and Type of Gates 3 Sets of Stoplogs

OUTLET WORKS: Same as Spillway

a. Type Timber Stoplogs

b. Location Spillway

c. Entrance Invert 1067.2

d. Exit Invert 1067.1

e. Emergency Draindown Facilities: Pull Stoplogs

HYDOMETEOROLOGICAL GAGES: None

a. Type N.A.

b. Location N.A.

c. Records N.A.

MAXIMUM NON-DAMAGING DISCHARGE:

(Lake Stage Equal to Top of Dam) 30 c.f.s.

APPENDIX 4

Hydraulic/Hydrologic Computations

STORCH ENGINEERS

Sheet 1 of 10

Project SILVER LAKE DAM

Made By JiHa Date 2/2/81

Chkd By JG Date 3/23/81

HYDROLOGY:

HYDROLOGIC ANALYSIS

INFLOW HYDROGRAPH FOR SILVER LAKE DAM WILL BE DEVELOPED BY HEC-1-DAM COMPUTER PROGRAM USING SCS TRIANGULAR UNIT HYDROGRAPH AND CURVILINEAR TRANSFORMATION

DRAINAGE AREA = 0.7 SQ MI.

INFILTRATION DATA:

DRAINAGE AREA IS WOODED USE:

INITIAL INFILTRATION	1.5 IN
CONSTANT INFILTRATION	0.15 IN/Hr.

Project SILVER LAKE DAM Made By Jitka Date 2/2/81

Chkd By JG Date 3/23/81

TIME OF CONCENTRATION:

[By SCS - TR-55]

LENGTH OF OVERLAND FLOW	=	6,700 Ft
AVERAGE SLOPE	=	4.1 %
AVERAGE VELOCITY	=	0.59 F.p.s

$$Tc = \left[\frac{6,700}{0.59}\right]\frac{1}{3,600} = 3.15 \text{ Hr}$$

TIME OF CONCENTRATION:

[By Handbook of Applied Hydrology - Chow - Pg 14-36]

$$Tc^{2.14} = 2/3\, L\eta/\sqrt{S}$$

$$Tc^{2.14} = \frac{2/3\,(6,700 \times 0.4)}{\sqrt{0.041}}\,\frac{1}{60}$$

$$Tc = 147.06 \text{ min}$$

$$Tc = 2.45 \text{ Hr}$$

Tc = Time of concentration [min]

S = Slope [%]

η = 0.4 Roughness coefficient

L = Length of overland flow [Ft]

TIME OF CONCENTRATION:

[By Design of small dams, Pg 71]

$$Tc = \left[\frac{11.9\,L^3}{H}\right]^{0.385}$$

$$Tc = \left[\frac{11.9\,(1.26)^3}{280}\right]^{0.385}$$

$$Tc = 0.39 \text{ Hr}$$

Tc = Time of concentration [Hr]

L = Length of longest watercourse [Mi]

H = Elevation difference [Ft]

STORCH ENGINEERS

Sheet 3 of 10

Project SILVER LAKE DAM

Made By JiHa Date 2/2/81

Chkd By JG Date 3/23/81

COMPUTER INPUT

FOR HEC - 1 - DAM

INPUT USE LAG TIME

Tc = 2.0 Hr LAG TIME = 60% Tc

LAG TIME = 1.2 Hr

STORCH ENGINEERS

Sheet 4 of 10

Project SILVER LAKE DAM Made By JHG Date 2/2/81

Chkd By JG Date 3/23/81

PRECIPITATION:

24 Hours, 100 year rainstorm distribution for SILVER LAKE DAM

TIME [Hr]	RAIN [IN]
1	0.08
2	0.08
3	0.08
4	0.08
5	0.08
6	0.08
7	0.09
8	0.09
9	0.18
10	0.18
11	0.18
12	0.19
13	0.3
14	0.3
15	0.8
16	3.0
17	0.4
18	0.3
19	0.19
20	0.18
21	0.09
22	0.09
23	0.08
24	0.08
24 Hr	Σ 7.2

FROM TP40 U.S. WEATHER BUREAU

STORCH ENGINEERS

Sheet 5 of 10

Project SILVER LAKE DAM Made By JiHa Date 2/2/81

Chkd By JG Date 3/23/81

LAKE STORAGE VOLUME:

WATER SURFACE ELEVATION [Ft]	AREA [Acres]
1,060	0
1,070	20.20
1,080	35.81
1,100	46.83

HEC - 1 - DAM PROGAM WILL DEVELOP STORAGE CAPACITY FROM SURFACE AREAS & ELEVATIONS.

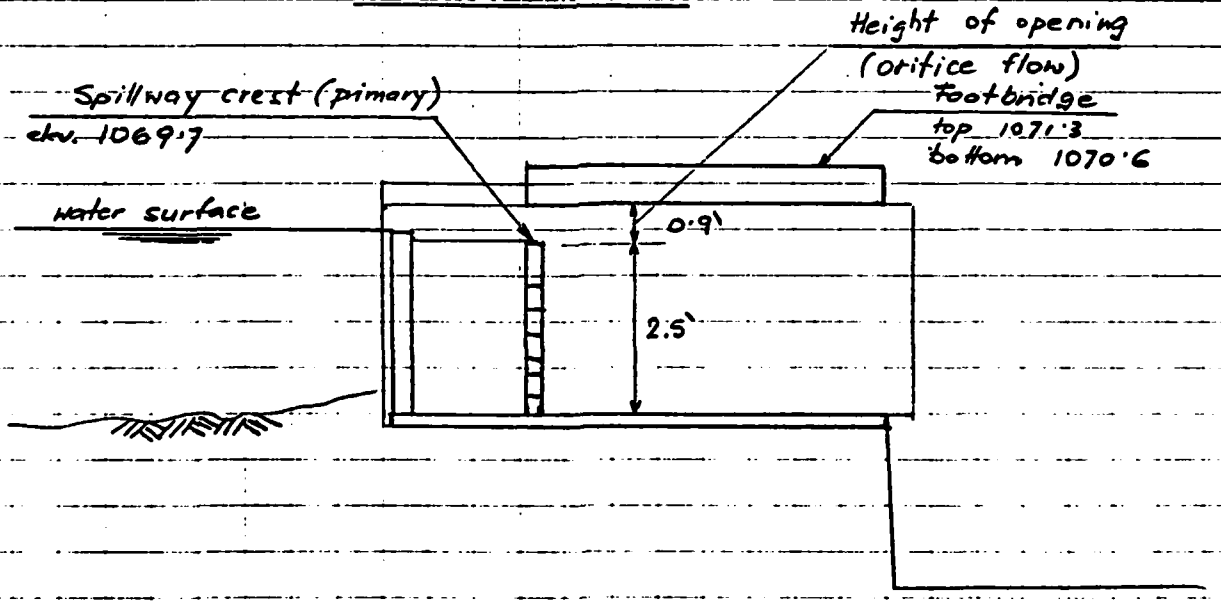
INFORMATION TAKEN FROM U.S.G.S. QUADRANGLE, Franklin, N.J.

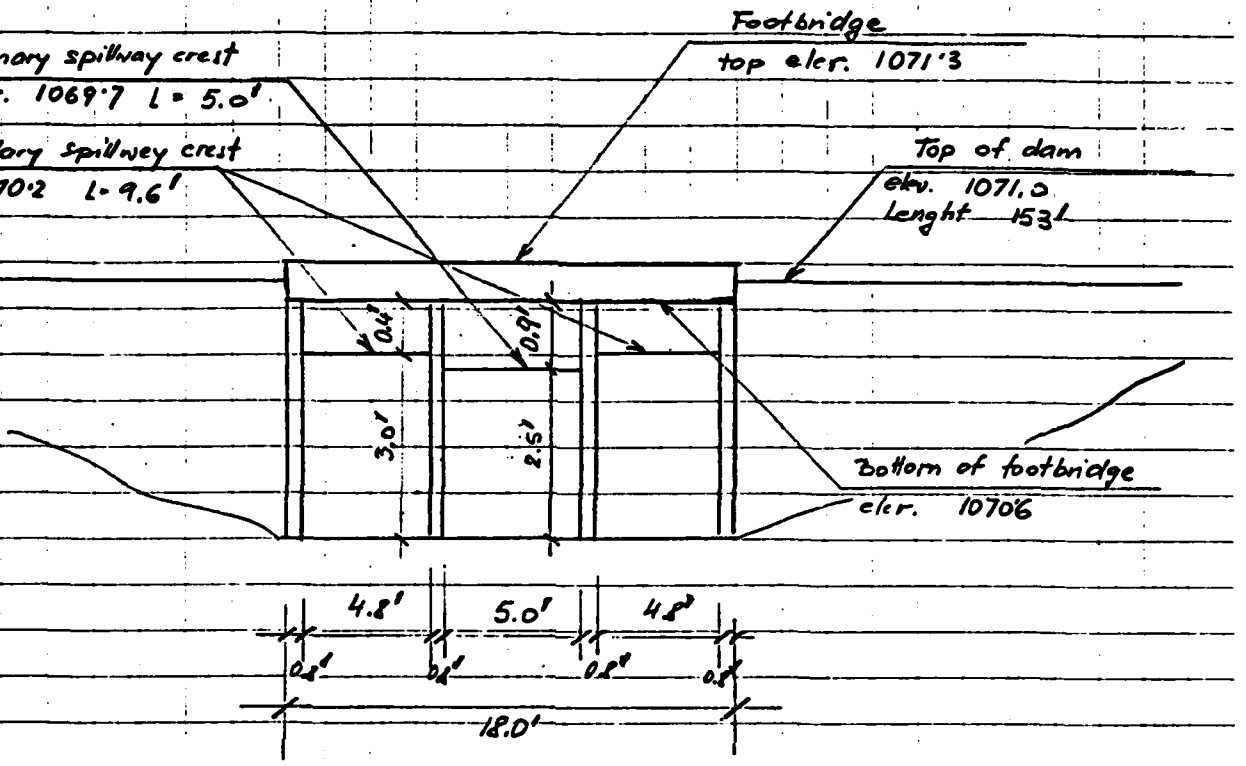
HYDRAULICS

DISCHARGE :

THE SPILLWAY AT SILVER LAKE DAM CONSISTS OF THREE (3) SHARP CRESTED WEIRS WITH CREST ELEVATIONS 1069.7 (PRIMARY CREST) AND 1070.2 (SECONDARY CREST) WITH EFFECTIVE LENGTHS OF 5.0 FEET AND 9.6 FEET, RESPECTIVELY

SPILLWAY SECTION





DISCHARGE WILL BE CALCULATED:

From elev. 1069.7 to elev. 1070.6

USING FORMULA: [Handbook of hydraulics. p. 5-3.]

$Q = C L H^{3/2}$

Q - discharge [cfs]

C - corfficient of discharge

L - effective length of spillway being overtopped [Ft]

H - head total on spillway [Ft]

STORCH ENGINEERS

Sheet 8 of 10

Project SILVER LAKE DAM Made By JiKa Date 2/2/81

Chkd By JG Date 3/23/81

From elev. 1070.6 and above

USING ORIFICE FORMULA: [Handbook of hydraulics Pg. 4-2]

$Q = Ca\sqrt{2gh}$

Q = discharge [cfs]

C = coefficient of 0.6

a = area of discharge [Ft²]

g = 32.2

h = head to centroid [Ft]

STAGE DISCHARGE TABULATION:

Water elev. [Ft]	WEIR primary H [Ft]	C	Q [cfs]	WEIR secondary H [Ft]	C	Q [cfs]	ORIFICE primary H [Ft]	Q [cfs]	ORIFICE secondary H [Ft]	Q [cfs]	ΣQ [cfs]
1069.7	0	0	0	0	0	0	0	0	0	0	0
1070.2	0.5	3.46	6.1	0	0	0	0	0	0	0	6.1
1070.6	0.9	3.46	14.8	0.4	3.47	8.4	0.45	14.5	0.2	8.3	~~23.2~~ 22.8
1071.6	0	0	0	0	0	0	1.45	26.1	1.2	14.3	40.4
1072.6	0	0	0	0	0	0	2.45	33.9	2.2	27.4	61.3
1073.6	0	0	0	0	0	0	3.45	40.3	3.2	33.1	73.4

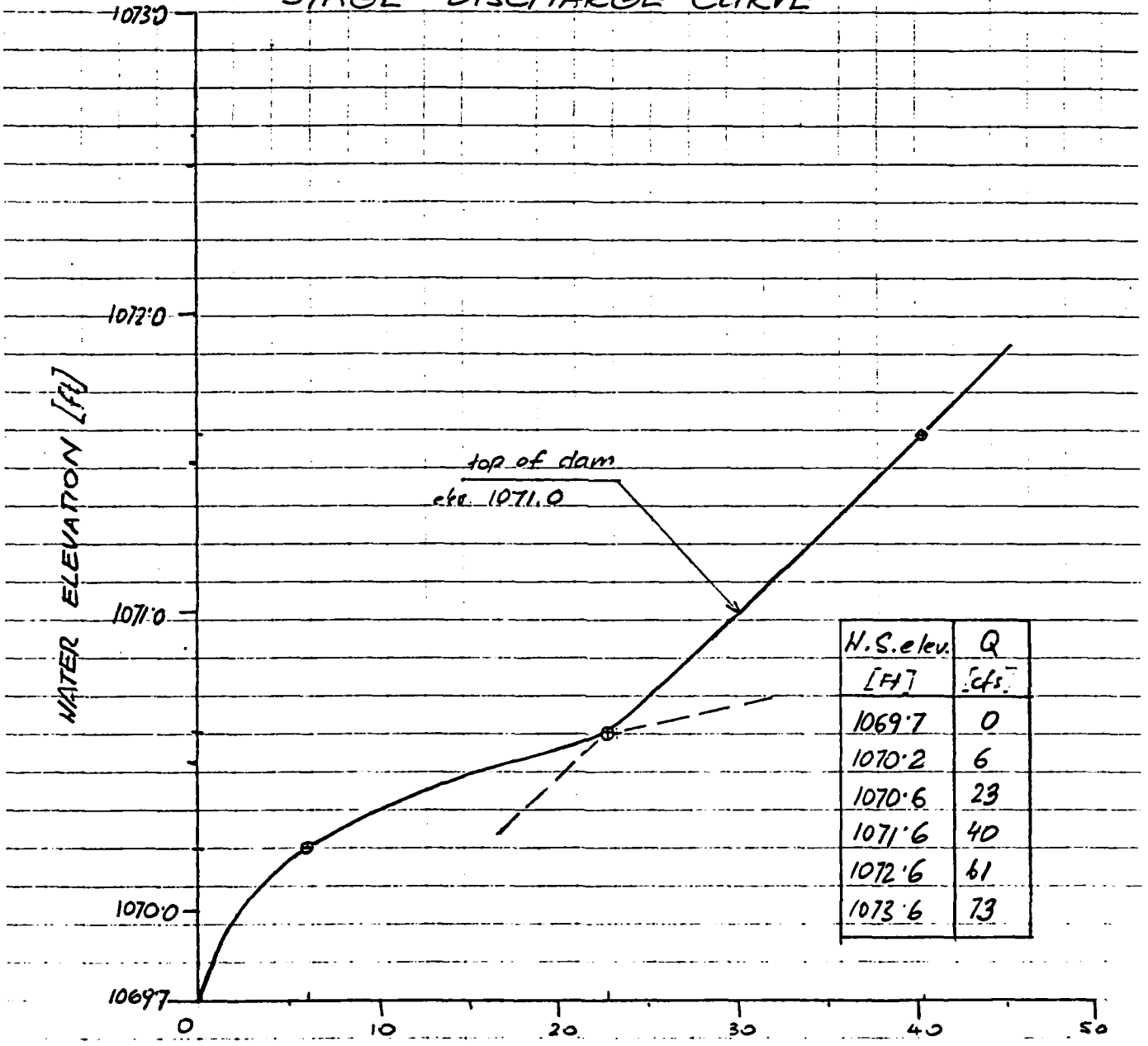
STORCH ENGINEERS

Sheet 9 of 10

Project SILVER LAKE DAM Made By JiHa Date 2/4/81

Chkd By JG Date 3/23/81

SPILLWAY STAGE DISCHARGE CURVE



W.S. elev. [ft]	Q [cfs]
1069·7	0
1070·2	6
1070·6	23
1071·6	40
1072·6	61
1073·6	73

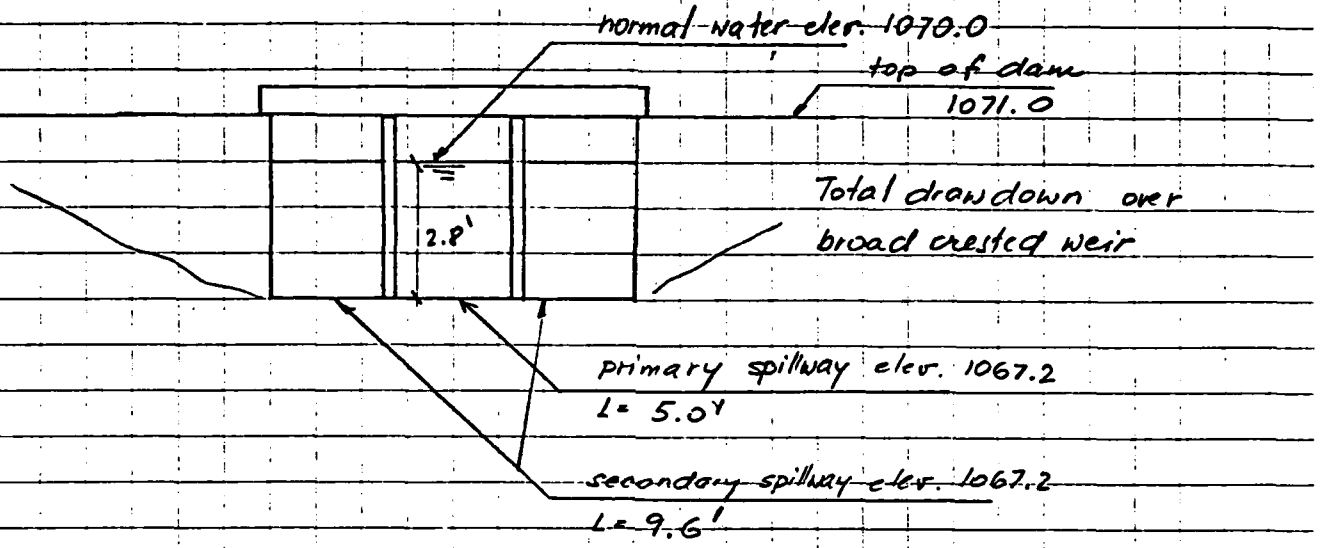
STORCH ENGINEERS

Sheet 10 of 10

Project SILVER LAKE DAM Made By JHa Date 2/4/81

Chkd By JG Date 3/23/81

DRAWDOWN :



Primary spillway: $Q = C L H^{\frac{3}{2}}$

$Q = 2.66 \times 5.0 \times 2.8^{\frac{3}{2}} = 62.3$ [cfs]

Assume lake drained through center stop logs

Aver. $H = 1.4'$

Aver. $Q = 2.6 \times 5.0 \times 1.4^{3/2} = 21.5$ c.f.s.

$T_d = \frac{\text{storage at spillway [Ac-ft]}}{\text{ave discharge [cfs]} - \text{inflow}}$ (Assume inflow = 0)

$T_1 = \frac{48}{21.5} \frac{43560}{3600} = 27.0$ Hr

Time of total drawdown is 27 Hr.

HEC - 1 - DAM PRINTOUT

Overtopping Analysis

```
1A1                    NATIONAL DAM SAFETY PROGRAM
A2                          SILVER LAKE DAM
A3                      100 YEAR STORM ROUTING
B     300       0      15                                    0       0       4
B1      5
J       1       1       1
J1      1
K       0    LAKE                          0       0       1
K1        INFLOW HYDROGRAPH TO SILVER LAKE DAM
M       0       2     0.7                 0.7       0                       1
O      96
O1  0.019   0.019   0.019   0.019   0.019   0.019   0.019   0.019   0.019   0.019
O1  0.019   0.019   0.019   0.019   0.019   0.019   0.019   0.019   0.019   0.019
O1  0.019   0.019   0.019   0.019   0.019   0.019   0.019   0.019   0.019   0.019
O1  0.019   0.019   0.019   0.019   0.019   0.019   0.019   0.019   0.019   0.019
O1  0.019   0.019   0.019   0.019   0.019   0.019   0.019   0.019   0.038   0.038
O1  0.038   0.038   0.038   0.038   0.038   0.038   0.038   0.038   0.038   0.038
O1  0.083   0.083   0.083   0.083   0.163   0.163   0.163   0.163   0.750   0.750
O1  0.750   0.750   0.163   0.163   0.163   0.163   0.083   0.083   0.083   0.083
O1  0.083   0.083   0.083   0.083   0.038   0.038   0.038   0.038   0.038   0.038
O1  0.038   0.038   0.038   0.038   0.038   0.038
T                                                   1.5    0.15
W2              1.2
X    -1.0   -0.05     2.0
K       1     DAM                                     1
K1        ROUTE DISCHARGE THROUGH DAM
Y                                       1       1
Y1      1                                           -1070.0      -1
Y4 1069.7  1070.2  1070.6  1071.6  1072.6  1073.6
Y5      0     6.1    22.8    40.4    61.3    73.4
Y6      0    20.2    35.8    46.8
$E   1060    1070    1080    1100
$$   1070
$D   1071    2.67     1.5     153
K       1       1                                       1
K1        CHANNEL ROUTING REACH 1
Y                                       1       1
Y1      1
Y6   0.08    0.04    0.08  1056.5  1062.5     100  0.0366
Y7      0  1062.5      40  1060.5      80  1058.5      80  1056.5      85  1056.5
Y7     85  1058.5     105  1060.5     125  1062.5
K       1       2                                       1
K1        CHANNEL ROUTING REACH 2
Y                                       1       1
Y1      1
Y6   0.08    0.04    0.08  1038.2  1044.2     500  0.0366
Y7      0  1044.2      40  1042.2      80  1040.2      80  1038.2      86  1038.2
Y7     86  1040.2     106  1042.2     126  1044.2
K      99
```

HYDROGRAPH ROUTING

ROUTE DISCHARGE THROUGH DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DAM	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1070.	-1

STAGE	1069.70	1070.20	1070.60	1071.60	1072.60	1073.60
FLOW	0.00	6.10	22.80	40.40	61.30	73.40
SURFACE AREA=	0.	20.	36.	47.		
CAPACITY=	0.	67.	344.	1167.		
ELEVATION=	1060.	1070.	1080.	1100.		

CREL	SPWID	COQW	EXPW	ELEVL	COOL	CAREA	EXPL
1070.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1071.0	2.6	1.5	153.

PEAK OUTFLOW IS 647. AT TIME 19.25 HOURS

```
1**********
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION      JULY 1978
   LAST MODIFICATION  26 FEB 79
**********

 RUN  DATE= 81/03/03.
      TIME= 04.56.09.
```

NATIONAL DAM SAFETY PROGRAM
SILVER LAKE DAM
100-YEAR STORM ROUTING

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	15	0	0	0	0	0	4	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 1 LRTIO= 1

RTIOS= 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH TO SILVER LAKE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
LAKE	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	2	.70	0.00	.70	0.00	0.000	0	1	0

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.50	.15	0.00	0.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= 1.20

RECESSION DATA

STRTQ= -1.00 QRCSN= -.05 RTIOR= 2.00

END-OF-PERIOD FLOW

0 MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	7.12	4.33	2.79	8253.
										(181.)(110.)(71.)(233.70)			

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1
				1.00
HYDROGRAPH AT	LAKE	.70	1	761.
		(1.81)		(21.56)(
ROUTED TO	DAM	.70	1	647.
		(1.81)		(18.32)(
ROUTED TO	1	.70	1	648.
		(1.81)		(18.36)(
ROUTED TO	2	.70	1	647.
		(1.81)		(18.32)(

RATIOS APPLIED TO FLOWS

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1070.00	1070.00	1071.00
STORAGE	67.	67.	88.
OUTFLOW	4.	4.	30.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1072.29	1.29	117.	647.	7.75	19.25	0.00

PLAN 1 STATION 1

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	648.	1060.9	19.25

PLAN 1 STATION 2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	647.	1042.5	19.25

APPENDIX 5

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